



Impaired vitality form recognition in autism



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ABSTRACT

Along with the understanding of the goal of an action ("what" is done) and the intention underlying it ("why" it is done), social interactions largely depend on the appraisal of the action from the dynamics of the movement: "how" it is performed (its "vitality form"). Do individuals with autism, especially children, possess this capacity? Here we show that, unlike typically developing individuals, individuals with autism reveal severe deficits in recognizing vitality forms, and their capacity to appraise them does not improve with age. Deficit in vitality form recognition appears, therefore, to be a newly recognized trait marker of autism.

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1. Introduction

The capacity of individuals to attribute goals and intentions to others has been a focus of much research. Many studies were performed in the frame of the so-called theory of mind (Premak & Woodruff, 1978), that is a specific cognitive ability that enables individuals to interpret the behavior of others in terms of mental states such as beliefs and desires (e.g. Baldwin, 1991; Baron-Cohen, 1991; Wimmer & Perner, 1983; Gergely, Bekkering, & Király, 2002; Meltzoff & Brookes, 2001). A milestone in theory of mind research was the demonstration that typically developing (TD) children are able by 4 years to understand that other people hold beliefs that are recognized as false (Wimmer & Perner, 1983). This finding acquired a particular importance by the discovery that children

with autism fail false belief tasks (Baron-Cohen, Leslie, & Frith, 1985). It was therefore proposed that the core deficit in autism is a deficit of theory of mind (Baron-Cohen, Tager-Flusberg, & Cohen, 1993; Frith, 2003; Leslie, 1987).

More recently, following the discovery of mirror neurons (di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996) and the subsequent demonstration that a subpopulation of mirror neurons code agent's intention (Bonini et al., 2011; Fogassi et al., 2005), a series of physiologically-inspired studies, were carried out to assess the capacity of TD children, children with autism (Cattaneo et al., 2007), and, more recently, children with Williams syndrome, to understand actions done by others (Sparaci, Stefanini, Marotta, Vicari, & Rizzolatti, 2012).

The capacity to understand others' actions is a complex process that requires the capacity to analyse the various action components. A first clear distinction must be made between understanding *what* the agent is doing (i.e., the goal of the observed action) and understanding *why* the agent is doing it (i.e., the intention underlying it). For example, when an individual observes another person moving his/her hand towards a mug, he or she immediately understands *what* the agent is doing (e.g., grasping the mug), but also he might understand *why* he is doing it (e.g., grasping the mug for drinking or grasping for moving it away).

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Although these two kinds of action understanding are often strictly intertwined, they appear to rely on different neural mechanisms (see Bonini et al., 2011; Fogassi et al., 2005).

Goal and intention understanding can be found dissociated one from another. Indeed, it has been shown that children with ASD do not differ from TD children when they are asked to recognize *what* an agent is doing, i.e., the action goal (Boria et al., 2009; Hamilton, Brindley & Frith, 2007). In contrast, they are impaired relative to TD children in understanding *why* an agent is performing a certain action, i.e., in understanding the intention of that action (Boria et al., 2009). More recently, it has been shown that children with Williams syndrome are impaired in understanding *what* the others are doing, compared to both mental-age and chronological-age TD controls, while they show mental-age appropriate performance in understanding *why* an individual is acting (Sparaci et al., 2012).

It is worth noting, however, that understanding an observed action does not consist only in recognizing what is the goal of an action and why that action has been performed. There is another fundamental component related to the dynamics of action that is critically involved in warranting social interactions with other people (Stern, 1985). Action dynamics enable the observer to understand the cognitive/emotional state of the agent of the performed action. For instance, a minute variation in the temporal contour, force, or direction of the actions may let the recipient of the action, as well as a neutral observer, to understand whether the agent is gentle or angry, whether he or she performs the action willingly or hesitating, and so on. The dynamics of action carrying this kind of information in a specific stretch of time has been called “vitality affects” (Stern, 1985) or “vitality forms” (Stern, 2010).

As stressed by Stern (2010) the concept of vitality refers to a *Gestalt*, a spontaneous integration of different dynamic events (movement, force, space, time, direction/intention) that are linked and perceived together in a coherent *whole*. It constitutes a phenomenal reality that is rooted in physical action but that would nevertheless lose its holistic meaning whenever fragmented into its physical composing elements. The perception of vitality forms is defined as “the felt experience of force in movement with a temporal contour and a sense of aliveness, of going somewhere”/“the felt experience of force in movement with a temporal contour and a sense of aliveness, of going somewhere” (Stern, 2010). Regardless of its content (thoughts, actions, emotions), the perceived *Gestalt* of vitality concerns the specific manner with which dynamic happenings unfold in space and time. It can thus be applied to every dynamic features emerging from the interpersonal relationships or time-based art expressions that “move us by the expression of vitality that resonate in us” (Stern, 2010, pp. 3–17).

There are no experiments that investigated whether individuals with ASD are impaired in *understanding* “vitality forms”. Some studies showed that children with ASD have difficulties in *imitating* actions performed with different “styles” (Hobson & Hobson, 2008; Hobson & Lee, 1999). In particular, it was shown that, while children with ASD do not differ from TD children in imitating the goal-directed component of relatively complex actions, they have difficulties in replicating the style (e.g. gentle or forceful) with which the action was demonstrated, especially when imitation of the style was not essential for achieving the action goal. The authors explained the failure of ASD children in incorporating the style of the demonstrator into their own repertoire in light of their weak propensity to identify themselves with others (Hobson, 1989, 1993, 2002). In conclusion, while it is clear that individuals with ASD often do not use the style of the demonstrator in replicating an observed action, it is still far from clear what might be the cause of this behavior. Is it restricted to the imitation domain? Or does it depend on a more fundamental deficit in recognizing different vitality forms?

To answer these questions we investigated the capacity of individuals with ASD and TD controls to recognize similarities and differences of actions characterized by same or different vitality forms. We will refer to this task as the *How* Task. Participants were also required to decide whether an observed action was similar or different relative to its goal, regardless of the vitality form with which it was executed. We will refer to this task as the *What* Task. The results showed a clear dissociation between the two tasks. Individuals with ASD did not differ from controls in the *What* Task. In contrast, they showed a clear deficit in the *How* Task. The significance of these findings for a better understanding of social and communicative deficits observed in autism will be discussed.

2. Materials and methods

2.1. Participants

Twenty patients with confirmed diagnosis of autism spectrum disorder (ASD) and 20 healthy controls took part in the experiment. Three of the patients with ASD had intelligence quotient (I.Q.) values under the intellectual normative range (< 71), and were discarded. Thus, the ASD group included 17 individuals: 6 were adolescents/adults (6 males aged from 14.0 to 19.2 years-old, mean = 16.1 ± 2.2) and 11 were children (9 males, 2 females aged from 6.10 to 12.8 years-old, mean = 9.9 ± 2.2). The group of healthy controls consisted of 6 adolescents/adults (6 males, aged from 13.3 to 18.6 years-old, mean = 16.2 ± 2.2) and 11 typically developing (TD) children (7 males, 4 females aged from 7.1 to 12.8 years-old, mean = 10.0 ± 1.7). None of them reported cognitive deficits.

Patients with ASD were recruited in 3 different clinical centers: in Italy, at the Center for Autism of Empoli (ASL 11), and at the Center for Communication and Socialization Disorders of Parma, and in France, at the Center for Functional Exploration and Neurophysiology in Pediatric Neuropsychiatry (CHU Bretonneau) in Tours. The diagnoses of autism were established independently by the team of clinical specialists pertaining to the different Centers for Autism, including qualified child and adolescent psychiatrists or pediatricians not associated with this research. Modules 2, 3 and 4 of the Autism Diagnostic Observation Schedule (ADOS) were used to confirm the diagnosis of ASD. In Module 2, scores from 8 to 12 indicate spectrum disorder, while autism is indicated by scores from 12 and above; in Modules 3 and 4 spectrum disorder is indicated by scores from 7 to 10, with the cut-off for autism fixed from 10 and above. Based on the results of this scale, 12 patients met the criteria for autism, while 5 patients met the criteria for spectrum disorder. All patients had an IQ > 71 calculated with the Wechsler Intelligence Scale for Adults (WAIS), the Wechsler Intelligence Scale for Children 3rd ed. (WISC-III), and Preschool and Primary Scale of Intelligence (WPPSI) depending on the participants' age. Table 1 reports chronological age, IQ, verbal age, and ADOS values for all participants of the ASD group.

The control group was matched to the ASD group for chronological and verbal age, the latest being evaluated using the Peabody Picture Vocabulary test-Revised (PPVT-R). Results from the two samples *t*-test analyses showed no significant differences between the two groups, either for what concerned the mean chronological age (ASD group, mean = $12.06 \pm SD = 3.72$; Control group, 12.18 ± 3.59 , $t(32) = -0.98$, n.s.) or the mean verbal age (ASD group, 113.15 ± 25.93 ; Control group, 127.19 ± 22.92 , $t(27) = 1.55$, n.s.).

PPVT-R scores were not available for 4 ASD patients who, however, presented no deficiencies at the Wechsler subtests of language comprehension and verbal reasoning. Those patients have been thus matched to controls for chronological age.

Table 1
Demographics for ASD and TD subjects participating in the study.

	ASD participants (N = 17) (Mean/SD)	TD participants (N = 17) (Mean/SD)
Chronological age	12.06 $\pm$ 3.72	12.18 $\pm$ 3.58
IQ	83.0 $\pm$ 10.87	NA
Verbal age (PPVT-R, raw scores)	113.15 $\pm$ 25.92	127.19 $\pm$ 22.92
ADOS (mod. 2) total algorithm	12.33 $\pm$ 4.04	NA
ADOS (mod. 3) total algorithm	13.00 $\pm$ 5.21	NA
ADOS (mod. 4) total algorithm	12.00 $\pm$ 4.34	NA

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